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Evaluation of Open Source SAR based Digital Elevation Models

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Digital Elevation Model (DEM) represents earth's terrain in 3-Dimension. Techniques such as interferometry, photogrammetry, and ground surveying can be used to generate them. DEMs can also be acquired from some free open source domains. Advanced Land Observing Satellite Phased Array type L-band Synthetic Aperture Radar (ALOS PALSAR), Shuttle Radar Topography Mission (SRTM), and TanDEM-X etc. are some of the free DEMs available in open source domain.

In the study, the comparative evaluation is performed for the DEM data sets from various open sources - ALOS PALSAR, SRTM and TanDEM-X with spatial resolution of 12.5m, 30m and, 12m respectively. ALOS PALSAR is an active microwave sensor with fine range resolution of 7m-44m at 28MHz. The sensor uses the L-band frequency. It was one of the three instruments on ALOS, with the main objective of land resources mapping, surveying, and disaster monitoring. SRTM was aimed at acquiring Radar data for creating land elevations for Earth surfaces. Earth Explorer provides free SRTM data in three different file formats and level of processing. SRTM DEMs are available in 30m and 90m spatial resolutions, of which 30m DEM were used for analysis. TanDEM-X is a radar remote sensing mission for Earth observation. It consists of SAR interferometer built by two almost identical satellites flying in close formation. The main objective of the mission is to create precise 3-D map of the Earth's land surfaces with unprecedented accuracy. The production of the DEM was completed in September 2016 with an absolute height error of about 1m. TanDEM-X 90m (3 arcsec) provides the DEM with resolution of 12m (0.4 arcsec). It represents the Digital Surface Model with horizontal and vertical datum of WGS84 ellipsoid.

In this study, the TanDEM-X DEM data for the Bhubaneshwar city was downloaded and evaluated with respect to ground measurements. 15 known ground reference points distributed over the whole area were selected and the values of the Z component of TanDEM-X were analysed. The Mean Error (ME), Mean Absolute Error (MAE), Root Mean Square Error (RMSE), Linear Error 90, and Cumulative Random Error (CRE) were calculated to evaluate the data sets. The ME of the ALOS PALSAR, SRTM, and TanDEM-X are -1.82m, 0.71m, and -0.24m, respectively. The MAE (0.83m) and RMSE (1.08m) of TanDEM-X are the least in comparison to those of ALOS PALSAR (MAE-2.70m; RMSE-3.06m) and SRTM (MAE-24.66m; 31.5m).The error of TanDEM-X DEM is within the prescribed vertical accuracy goal of EOC Geoservice Data Guide, from which it can be concluded that TanDEM-X shows highest accuracy out of the three DEMs analysed. The CRE for ALOS PALSAR, SRTM and TanDEM-X are -8.45, -77.5 and -2.61 respectively. The LE90 of TanDEM-X is also found to be minimum (1.78m) out of all the three DEMs analysed.

The study shows that although the spatial resolutions of ALOS PALSAR and TanDEM-X are almost equal, TanDEM-X shows more degree of accuracy. Hence, there is a higher potential for TanDEM-X 90m data products for terrain information extraction, and it can be used for various applications and analyses such as, urban planning, transportation, hydrological analysis, infrastructure planning works, etc.